

**MODEL ANSWERS**

**Name:** \_\_\_\_\_

**ID Number:** \_\_\_\_\_

**Time: 2 hours**

1 <b>H</b> 1.008	2 <b>He</b> 4.003
3 <b>Li</b> 6.941	4 <b>Be</b> 9.012
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31
19 <b>K</b> 39.10	20 <b>Ca</b> 40.08
21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88
23 <b>V</b> 50.94	24 <b>Cr</b> 52.00
25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85
27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69
29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.38
31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59
33 <b>As</b> 74.92	34 <b>Se</b> 78.96
35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62
39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22
41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94
43 <b>Tc</b> (98)	44 <b>Ru</b> 101.1
45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.4
47 <b>Ag</b> 107.9	48 <b>Cd</b> 112.4
49 <b>In</b> 114.8	50 <b>Sn</b> 118.7
51 <b>Sb</b> 121.8	52 <b>Te</b> 127.6
53 <b>I</b> 126.9	54 <b>Xe</b> 131.3
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3
57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5
73 <b>Ta</b> 180.9	74 <b>W</b> 183.9
75 <b>Re</b> 186.2	76 <b>Os</b> 190.2
77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1
79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6
81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2
83 <b>Bi</b> 209.0	84 <b>Po</b> (209)
85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> 226
89 <b>Ac<sup>†</sup></b> (227)	

QUESTION	SCORE	MAXIMUM MARKS
1		
2		
<b>TOTAL</b>		

## QUESTION 1

**(a) Read the following passage about water and answer the questions that follow.**

### Water

Water is the most abundant compound on earth and covers about 70% of the earth's surface. It is a polar solvent that has an angular structure and dissolves both ionic compounds and polar covalent compounds. Therefore, it is a vitally important solvent in living systems. At room temperature, water is a colourless liquid. Water molecules are strongly attracted to one another by a chemical force called intermolecular hydrogen bonding. At sea level, water boils at 100°C. The density of water at room temperature is 0.99708 g/cm<sup>3</sup>. Water is a very weak conductor of electricity. In the process of electrolysis, water splits into hydrogen gas and oxygen gas.

(i) List all the **physical properties** of water mentioned in the passage above. (*You will lose marks for including wrong information*).

**Physical properties: properties that are observed or measured without changing the identity of the substance:**

**Polar solvent**

**Angular structure**

**Dissolves both ionic and polar covalent compounds**

**Colourless**

**Liquid**

**Exhibits intermolecular hydrogen bonding**

**Boiling point of water is 100°C at sea level**

**Density of water is 0.99708 g/cm<sup>3</sup>**

**Weak conductor of electricity**

(ii) List all the **chemical properties** of water mentioned in the passage above. (*You will lose marks for including wrong information*).

**Chemical properties: properties that are observed or measured with a change in the identity of the substance:**

**Electrolysis of water: water is split with electricity into hydrogen gas and oxygen gas**

**(b)** Give the name of each of the processes represented by the following equations.

(i) $I_2(s) \rightarrow I_2(g)$	<b>Sublimation of iodine</b>
(ii) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	<b>Chemical reaction: formation of water</b>
(iii) $H_2O(g) \rightarrow H_2O(l)$	<b>Condensation</b>
(iv) $Br_2(l) \rightarrow Br_2(g)$	<b>Vaporisation (Evaporation)</b>
(v) $XY \rightarrow X^+ + Y^-$ <b>(dissociation)</b>	<b>Heterolytic bond cleavage</b>
(vi) copper wire (25°C) → copper wire (100°C)	<b>Heating (conductivity of heat)</b>

**(b)** Write the name of each of the following substances:

$HIO_2(aq)$	<b>Iodous acid</b>
$MnCrO_4$	<b>Manganese(II) chromate</b>
$P_4S_3$	<b>Tetraphosphorus trisulfide</b>
$CaH_2$	<b>Calcium hydride</b>
$Bi(BrO)_3$	<b>Bismuth(III) hypobromite</b>
$PtO_2 \cdot H_2O$	<b>Platinum(IV) oxide monohydrate</b>
$TiP$	<b>Titanium(III) phosphide</b>
$Al_2(SO_4)_3 \cdot 18H_2O$	<b>Aluminium sulfate octadecahydrate</b>
$RbO_2$	<b>Rubidium superoxide</b>
$Co(NO_2)_2$	<b>Cobalt(II) nitrite</b>

**(d)** Write a formula for each of the following substances:

Ammonium lactate <b>NH<sub>4</sub>C<sub>3</sub>H<sub>5</sub>O<sub>3</sub></b>	<b>CH<sub>3</sub>CH(OH)COONH<sub>4</sub> or NH<sub>4</sub>CH<sub>3</sub>COO</b>
Hydrogen peroxide	<b>H<sub>2</sub>O<sub>2</sub></b>
Iron(III) nitrate nonahydrate	<b>Fe(NO<sub>3</sub>)<sub>3</sub>·9H<sub>2</sub>O</b>
Scandium(III) thiocyanate	<b>Sc(SCN)<sub>3</sub></b>
Formic acid	<b>HCOOH</b>
Potassium permanganate	<b>KMnO<sub>4</sub></b>
Dinitrogen pentoxide	<b>N<sub>2</sub>O<sub>5</sub></b>
Mercury(II) carbide	<b>Hg<sub>2</sub>C</b>
Aluminium hydrogen carbonate	<b>Al(HCO<sub>3</sub>)<sub>3</sub></b>
Tin(IV) perchlorate	<b>Sn(ClO<sub>4</sub>)<sub>4</sub></b>

**(d) State** whether each of the following is **CORRECT** or **WRONG**. Then **say** what the **mistake or error** is. An example is given.

		<b>CORRECT T or WRONG</b>	<b>What is the mistake?</b>
Mg	Manganese	WRONG	The name of the element is wrong
Water	H <sub>2</sub> O	CORRECT	-
SrS	Strontium sulfide	<b>CORRECT</b>	-
Pd(IO) <sub>2</sub>	Palladium(II) hypoiodide	<b>WRONG</b>	<b>The suffix of the name of the anion is wrong</b>
Cd <sup>2+</sup>	Cadmium ion	<b>CORRECT</b>	-
F <sup>-</sup>	Flouride ion	<b>WRONG</b>	<b>The spelling is wrong</b>
Cu <sub>2</sub> Se	Copper(II) selenide	<b>WRONG</b>	<b>The charge of the copper atom is wrong</b>
NH <sub>4</sub> CH <sub>3</sub> COO	Ammonium acetate	<b>WRONG</b>	<b>The chemical formula is written wrongly with the cation not attached to the carboxylate ion</b>
			<b>The physical state is not</b>

HCN	Hydrocyanic acid	<b>WRONG</b>	<b>indicated in the chemical formula</b>
Hg <sub>2</sub> Cl <sub>2</sub>	Mercury(I) chloride	<b>WRONG</b>	<b>The symbol of the chloride ion is wrong</b>

**(e) Complete** the following statements:

(i) A substance that is attracted to a **magnetic field** contains unpaired electrons and is described as **paramagnetic**

(ii) The maximum number of unpaired electrons in any subshell is  **$2\ell + 1$**

(iii) The symbol of the element in Period 4 that has the largest number of unpaired electrons in the ground state is **Cr**

(iv) An example of a metallic polyatomic cation is **Hg<sub>2</sub><sup>2+</sup>**

(v) An example of a nonmetallic cation is **NH<sub>4</sub><sup>+</sup>**

(vi) The **three classes** of the elements of life (elements in the human body) according to amounts are **major elements, major minerals** and **trace elements**

(vii) The deficiency of iron in humans causes the disease called **anemia** (or **anaemia**). Two examples of proteins in humans that bind iron are **hemoglobin** (**haemoglobin**) and **myoglobin**

(viii) The sizes and **metallic** character of elements increase on going down a group.

(ix) The monatomic ions of hydrogen are **H<sup>+</sup> (proton)** and **H<sup>-</sup> (hydride ion)**

(x) According to the Bohr model, the electron of the hydrogen atom is in a circular **orbit** at a distance of **52.92 pm** away from the **nucleus**. However, in the **quantum mechanical** model that uses the **Schrödinger** equation, a graph of the **radial probability**

distribution *versus* the radius of the  $1s$  atomic orbital shows that the **most probable**

distance at which the electron is located away from the nucleus is **52.92 pm**.

(xi) Atomic orbitals in the same subshell have exactly equal **energy** and are, therefore, described as **degenerate**.

A node is **a region in an atom that has zero probability of finding an electron**

(xii) When an atom ionizes, the electron goes to the energy level  **$n = \infty$**

(xiii) The electron configuration of the silver ion is:



(xiv) When oleic acid is deprotonated, the ion formed is called **oleate ion**

(xv) The names of the two elements whose deficiency causes bone weakness are:

**Calcium** and **phosphorus**

(xvi) Metals are classified as main-group or **transition**

(xvii) Tellurium is classified as a **metalloid** and a **chalcogen**

(xix) Metals **lose** electrons when they form ionic compounds; therefore they are said to be **reducing** agents.

(xx) Hund's rule states that the lowest energy **electron configuration** for an atom

is the one **with the maximum number of unpaired electrons** in a particular

set of **degenerate** orbitals.

(xxi) The types of covalent bonds are **nonpolar covalent** and **polar covalent**.

These are distinguished by the **electronegativity difference**

between the atoms bonded together. On the other hand, covalent bonds can be classified as

triple, double and **single** according to their **bond order**.

Double and triple bonds are together known as **multiple bonds**.

In such bonds (double and triple), the overlap of orbitals results in two types of chemical bonding,

namely  **$\sigma$ -bonding** and  **$\pi$ -bonding**.

The length of a covalent bond is defined as **the internuclear distance between the atoms**

**covalently bonded together**

The bond length of  $\text{Br}_2$  is 228.4 pm and that of  $\text{BrCl}$  is 213.8 pm. Thus we estimate the

bond length of  $\text{Cl}_2$  to be **199.2 pm**.

From the Lewis structures of **ozone**, **peroxide ion** and **molecular oxygen**, we can arrange the

bond lengths of these substances as follows:

**peroxide ion > ozone > molecular oxygen**

## QUESTION 2

(a) Draw the Lewis dot symbol of the following:

(i) Selenium

(ii) The aluminium ion.

(b) **Draw** the **molecular shapes** of the following substances and **name** them. Assign **polarity**.

**Dinitrogen monoxide** (N is the central atom)

**NH<sub>2</sub><sup>-</sup>**

**SOCl<sub>2</sub>**

**XeO<sub>2</sub>F<sub>2</sub>**

(c) **Discuss** fully the structure of the **acetate ion**.